



U.S. DEPARTMENT OF
ENERGY



NATIONAL
ENERGY
TECHNOLOGY
LABORATORY

CSN

CARBON STORAGE

NEWSLETTER

VOL. 22, NO. 2

CARBON STORAGE PROGRAM DOCUMENTS and REFERENCE MATERIALS

- ▷ Carbon Storage Educational Resources
- ▷ Program Reports, Plans, and Roadmaps
- ▷ Conference Proceedings
- ▷ Carbon Storage Portfolio
- ▷ Systems Analysis
- ▷ Peer Review
- ▷ Best Practices Manuals
- ▷ Fossil Energy and Carbon Management Techlines

This newsletter is compiled by the National Energy Technology Laboratory to provide information on recent activities and publications related to carbon storage. It covers domestic, international, public sector, and private sector news in the following areas:

DOE/FECM/NETL
HIGHLIGHTS

ANNOUNCEMENTS

PROJECT and BUSINESS
DEVELOPMENTS

LEGISLATION
and POLICY

EMISSIONS TRADING

SCIENCE

PUBLICATIONS

ABOUT CSN

DOE/FECM/NETL HIGHLIGHTS



DOE Announces Funding for CO₂ Utilization.

The U.S. Department of Energy's (DOE) *Bioenergy Technologies Office (BETO)* in the Office of Energy Efficiency and Renewable Energy (EERE) and the Office of Fossil Energy and Carbon Management's (FECM) Carbon Utilization Program announced the availability of federal funding for the advancement of technologies that utilize waste carbon to reduce greenhouse gas (GHG) emissions and produce reliable feedstocks for biotechnologies. The Funding Opportunity Announcement (FOA), titled "*Carbon Utilization Technology: Improving Efficient Systems for Algae*," specifically aims to increase the capability of algal systems to capture carbon dioxide (CO₂) and put it to productive use. Concept papers for the FOA are due March 18, 2022; applications are due May 27, 2022.

From *energy.gov*. February 2022.

DOE/FECM/NETL HIGHLIGHTS (cont.)

FECM's 2021 Year in Review.

Dr. Jennifer Wilcox, the Acting Assistant Secretary for DOE's FECM, shared highlights of FECM's 2021. Achievements included adding "Carbon Management" to the office's name; updating the mission to focus on minimizing impacts of fossil fuels to help the nation achieve net-zero GHG emissions; providing funding to 40 research projects to advance carbon management approaches (such as carbon capture and storage [CCS] and CO₂ removal); and launching key carbon management initiatives. To keep up to date with future FECM announcements, blogs, and more, sign up for FECM's [news alerts](#).

From [energy.gov](#). December 2021.



ANNOUNCEMENTS

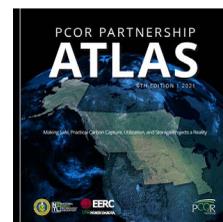
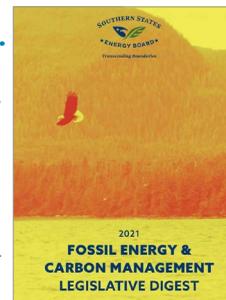
DOE, USGS to Explore CCS.



DOE's FECM and the U.S. Department of Interior's U.S. Geological Survey (USGS) announced a partnership to explore global, regional, and national resources for the geologic storage of CO₂. Under the [Memorandum of Understanding \(MOU\)](#), the agencies will collaborate with international governments, geologic surveys, and other organizations to provide technical assistance through a series of discussions, meetings, workshops, and research activities. The information will be used by government, academia, industry, research organizations, and other stakeholders to help identify potential investment opportunities for research, development, demonstration, and deployment to advance CCS technologies for application in power and industrial sectors.

Fossil Energy and Carbon Management Legislation Digest Available.

The Southern States Energy Board released a publication focused on fossil energy and carbon management legislation in the United States. The [Fossil Energy and Carbon Management Legislative Digest](#) covers regulatory measures affecting fossil energy generation; carbon capture, utilization, and storage (CCUS); and decarbonization bills.



PCOR Partnership Atlas Available.

The [Plains CO₂ Reduction \(PCOR\) Partnership Initiative](#), one of four FECM Regional Initiative projects, released the [PCOR Partnership Atlas, 6th Edition](#). The atlas provides a regional profile of CO₂ sources and potential storage locations across the PCOR Partnership region (approximately 2.4 million square miles from Missouri to Alaska, including 10 U.S. states and four Canadian provinces).

NRAP Report Recommends Practices for Carbon Storage Induced Seismicity Risk Management.

Researchers collaborating through DOE's National Risk Assessment Partnership (NRAP) released a technical report that presents a framework and steps to systematically evaluate, manage, communicate, and mitigate the risk of induced seismicity at geologic carbon storage sites. "[Recommended Practices for Managing Induced Seismicity Risk Associated with Geologic Carbon Storage](#)" builds on earlier work from DOE's Geothermal Technologies Office, incorporating new insights, and is adapted to cover a carbon storage project's life cycle.



Honeywell, University of Texas at Austin, to Develop CCS Technology.

Honeywell announced an agreement with the University of Texas at Austin (UT Austin) that will enable the capture of CO₂ emissions from power plants and industry. Under the licensing agreement, Honeywell will leverage UT Austin's proprietary advanced solvent technology to provide heavy industrial plants an additional tool to help meet regulatory requirements and sustainability goals.

CCUS-Focused Magazine Launched.

BBI International, a producer of bioenergy trade magazines, announced the launch of [Carbon Capture Magazine](#). There will be one print issue in 2022, as well as a carbon capture industry directory and a map of storage and capture facilities. The magazine will also produce weekly online stories and distribute a bi-weekly newsletter.



Companies Seek to Develop CO₂ Storage Off Norway.

Five companies applied to develop CO₂ storage technology on the Norwegian continental shelf. The Norwegian government is seeking to promote the development of CCS technology to help reach climate goals. The country's oil and energy ministry said plans call for the allocation of the offshore acreage for CO₂ storage in 2022.

CCUS Partnership to Implement Roadmap.

The Technical University of Denmark entered a CCUS partnership with representatives from universities, public sector research, industry, and approved technological service institutes. The partnership, INNO-CCUS, will implement a Danish CCUS roadmap focused on short-term, medium-term, and long-term climate solutions.

Company Signs LOI for CCUS Deployment.

McDermott—a U.S. offshore engineering and construction company—and the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) signed a Letter of Intent (LOI) to evaluate technical and commercial opportunities for the deployment of CSIRO's carbon capture technologies for energy and heavy industry applications.



PROJECT AND BUSINESS DEVELOPMENTS



CarbonSAFE Project Drills Second Exploratory Well.

DOE's Carbon Storage Assurance Facility Enterprise (CarbonSAFE) Wyoming team began drilling a second characterization test well near Basin Electric Power Cooperative's Dry Fork Station (near Gillette, Wyoming). Adjacent to the first well (completed in 2019), the second well will allow researchers to gather data and more fully characterize the geologic layers of the subsurface site. **CarbonSAFE Initiative** projects focus on the development of geologic storage sites for the storage of 50+ million metric tons of CO₂ from industrial sources. The Wyoming CarbonSAFE team is led by the University of Wyoming School of Energy Resources (SER).

From *University of Wyoming News Release*. January 2022.

Dutch Energy Companies Sign Contract for CCUS Project.

Air Liquide, Air Products, ExxonMobil, and Shell signed contracts with the Port of Rotterdam CO₂ Transport Hub and Offshore Storage (Porthos) project, which will store 2.5 million metric tons of CO₂ as of 2024. The Porthos project will transport the CO₂ to a depleted gas field approximately 12 miles off the coast; it will then be stored under the North Sea seabed.



From *Offshore Energy*. December 2021.

Denmark Awards Grant to CCS Project.

The Danish Energy Agency awarded a grant to a consortium backing the Greensand CCS project in the North Sea. Greensand is located off the coast of Denmark and has a storage potential of up to 1.5 million metric tons of CO₂ per year from 2025, increasing to 8 million metric tons per year by 2030.

From *Reuters*. December 2021.

CCS Project Supported with New Platforms.

Neptune Energy will develop new "digital twins" of two drilling and production platforms in support of its offshore CCS project. The global exploration and production company will use digitized versions of the area to reduce costs and environmental impacts by enabling engineers to work onshore. The digitized versions will allow engineers to conduct work from onshore locations and advance the CCS facilities.

From *Gas World*. December 2021.

LEGISLATION AND POLICY



UK Government Launches BECCS Program.

The United Kingdom (UK) government launched a program to support the development of technologies to produce hydrogen generated from biomass with carbon capture and storage (BECCS). Applicants can bid for a share of government funding under Phase I of the Hydrogen BECCS Innovation Programme to help develop their project plans and demonstrate feasibility. A second phase will follow, providing more funding to the most promising Phase I projects. The program is funded through the UK Department for Business, Energy, and Industrial Strategy.

From *Renewable Energy Magazine*. January 2022.



Department for
Business, Energy
& Industrial Strategy

Partnership to Explore CCS in Malaysia.

Malaysia's state oil firm Petronas and Royal Dutch Shell signed an agreement to collaborate on CCS in Malaysia. Under the agreement, Petronas and Shell will perform an integrated CCS development plan study at several locations offshore Sarawak. The scope of the agreement includes exploring the provision of decarbonization services to Shell's local and cross-border facilities, as well as to other potential regional customers.

From *Reuters*. January 2022.

EPA Approves CCS Project in Permian Basin.

The U.S. Environmental Protection Agency (EPA) approved Lucid Energy Group's monitoring, reporting, and verification (MRV) plan to store CO₂ in the Permian Basin. The MRV plan documents Lucid's means of safely ensuring the capture and storage of CO₂ from its Red Hills gas processing complex in Lea County, New Mexico (USA). **Lucid Energy Group** is a privately held natural gas processor in the Permian Basin servicing New Mexico and West Texas.

From *Lucid Energy Group News*. January 2022.



ADM Signs CO₂ Capture, Transport Deal.



Archer Daniels Midland (ADM) signed an LOI with Wolf Carbon Solutions to build a pipeline that would capture and transport CO₂ from ADM's ethanol facilities in Iowa (USA) to a storage site in Decatur, Illinois, USA. The 350-mile steel pipeline is expected to be capable of transporting 12 million metric tons of CO₂ per year, according to ADM.

From *Reuters*. January 2022.

Summit Carbon Solutions, Northern Plains Nitrogen, Partner on CCS Project.

Summit Carbon Solutions and **Northern Plains Nitrogen (NPN)** will partner on a CCS project focused on decarbonizing the agriculture and biofuels industries. NPN will capture 500,000 tons of CO₂ emissions per year at a blue ammonia plant under development near Grand Forks, North Dakota, that will supply low-carbon nitrogen-based fertilizer in the northern United States and Canada. Summit Carbon Solutions will transport and store the CO₂ in central North Dakota.

From *Summit Carbon Solutions News*. January 2022.

EMISSIONS TRADING



RGGI States Initiate Auction Process.

The states participating in the Regional Greenhouse Gas Initiative (RGGI) released the [Auction Notice](#) and application materials for their 55th quarterly CO₂ allowance auction (scheduled to be held March 9, 2022). Auction 55 will offer 21,761,269 CO₂ allowances for sale at a minimum reserve price of \$2.44. In addition, an 11,611,278 CO₂ allowance cost containment reserve (CCR) will be made available, as will an emissions containment reserve (ECR) of 10,961,898 allowances. (The CCR is a fixed additional supply of allowances made available if CO₂ allowance prices exceed the CCR trigger price of \$13.91. The ECR is a designated quantity of allowances to be withheld if the auction's interim clearing price is less than the ECR trigger price of \$6.42.)



From *RGGI*. January 2022.

Vietnam to Pilot Carbon Trade Exchange.

Vietnam plans to set up and pilot a carbon trade exchange beginning in 2025, according to a government decree on GHG emissions. From now until the end of 2027, according to the document, the country will put forward regulations on the management of carbon credits, the exchange of GHG emissions quotas and carbon credits, and the operation of a carbon credit exchange. The carbon trade exchange is expected to be put into official operation in 2028.

From *The Star*. January 2022.

SCIENCE

Company Tests CO₂ Monitoring Technology.

Carbon Management Canada (CMC) and UK-based TensorGEO Ltd. are testing the use of passive seismic data to monitor CO₂ storage at CMC's Field Research Station (FRS) in Alberta, Canada. According to TensorGEO, their technology can continuously monitor reservoir integrity while tracking fluid velocity-related changes when it comes to CCS. TensorGEO's partnership with CMC allows them to test their technology by utilizing already acquired passive seismic data from the FRS and deploying the technology at the FRS to further validate its capability.

From *Carbon Capture Journal*. December 2021.

Researchers Study CO₂ Conversions, Failures.

Researchers from the [Massachusetts Institute of Technology \(MIT\)](#) studied potential reasons for failure(s) in CO₂ conversion, identifying possible solutions in the process. The study identified, quantified, and modeled CO₂ conversion systems, finding that a local depletion of the CO₂ gas next to the electrodes being used to catalyze the conversion could lead to potential poor performance. According to the findings, [published in the journal *Langmuir*](#), a potential solution resides in pulsing the current off and on at specific intervals, allowing time for the gas to build back up to the needed levels next to the electrode.



From *Science Daily*. January 2022.

Carbon Permit Trades Up in 2021.

The Intercontinental Exchange (ICE) saw a record number of carbon allowance trades in 2021, up almost 30% from the previous year, according to the company. A total of 18.3 billion tons of carbon allowances were traded on the exchange in 2021 (up from 14.3 billion in 2020). Approximately 15.2 billion tons were trades of European Union allowances (up from 12.17 in 2020); 2.4 billion were California carbon allowances (up from 1.87 billion in 2020); 255 million were from Britain's emission trading system, which launched in 2021; and approximately 346 million were RGGI allowances (up from 231.5 in 2020).

From *Reuters*. January 2022.

Global Carbon Emissions Reduction Contract to Launch.

Net Zero Markets, through signed agreements with the European Energy Exchange (EEX) and AirCarbon Exchange (ACX), will launch Global Emission Reduction (GER)[®], a product that will address potential issues in the Voluntary Carbon Market (VCM). Net Zero expects the GER to be progressively listed on the exchanges and commence trading in early 2022.

From *Yahoo! Finance*. January 2022.



Ecologists Study Carbon Cycles.

Ecologists from Colorado State University (CSU) are studying how co-occurring droughts and deluges impact carbon cycling. The CSU researchers are combining field experiments and computer modeling to assess the impact on carbon cycling across the vast grasslands of the continental United States. The region of interest will be a 174,000-mi², semi-arid shortgrass steppe located at the western edge of the U.S. Great Plains; however, the research will be conducted within the Central Plains Experimental Range, a 15,500-acre area managed by the U.S. Department of Agriculture's Agricultural Research Service.

From *Colorado State University College of Natural Sciences*. January 2022.



**COLORADO STATE
UNIVERSITY**

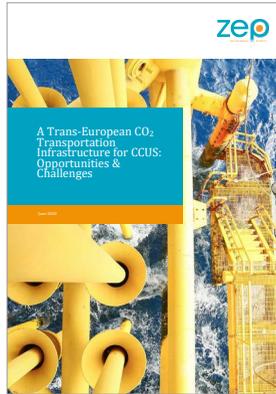


PUBLICATIONS



A Trans-European CO₂ Transportation Infrastructure for CCUS: Opportunities & Challenges.

The following is from a description of this Zero Emissions Platform report: “This report looks at the challenges and opportunities for CO₂ transport in Europe, including pipelines and other modes of transport. It provides an overview of CO₂ transportation, particularly in industrial clusters, and highlights the importance of developing dedicated business models, as well as enabling policy framework, for CO₂ transportation. This report is particularly relevant in the context of the European Green Deal, as CO₂ infrastructure is crucial to deliver large-scale decarbonisation across industry and energy sectors, which will be necessary to achieve climate-neutrality.”



The \$2 Trillion Transition: Canada's Road to Net Zero.

The following is from the Executive Summary of this report: “To get on a more serious path to Net Zero, the [Canadian] federal government committed to getting Canada back to around 500 million tonnes by the end of this decade—and eliminating or offsetting the rest by 2050, using new technologies like electric vehicles, new heat sources for homes, and new processes to capture and store some of the emissions that [continue to be produced to power the planet]. This report aims to map out some of those pathways, as well as the investments and policies needed to achieve Net Zero. [The authors] use a range of established modelling on the emissions of major sectors, and the potential of breakthrough technologies, behavioural changes and improvements in industrial and agriculture processes. [The authors'] research aims to project out, over 30 years, what the estimated long-term costs and benefits could be, understanding that many uncertainties exist around climate, technology and behavioural trends and such forecasts will continue to evolve.”



Bio-energy with carbon capture and storage via alkaline thermal Treatment: Production of high purity H₂ from wet wheat straw grass with CO₂ capture.

The following is from the abstract of this article: “Biomass has a unique potential for “negative emissions” of CO₂ if carbon capture and storage are integrated into the biomass conversion. While a large body of research has explored biomass conversion, challenges such as low energy density and high moisture content persist. This study proposes and investigates a novel single-step reaction scheme called Alkaline Thermal Treatment (ATT) to convert a real biomass feedstock (e.g. wet wheat straw grass) into high purity H₂ in the presence of alkali (e.g., NaOH) at a moderate temperature of 500°C and ambient pressure. Importantly, negligible CO and a very low percentage of CO₂ (0.3%) were detected in the product gas stream, thus rendering gas products from the ATT reaction usable in various applications including fuel cells without further gas purification steps. The solid residue contained a very high percentage of carbonate, confirming the in-situ carbon capture effect.”

Hui Zhou and Ah-Hyung Alissa Park, *Applied Energy*. (Subscription may be required.)

The CO₂ cost pass-through and environmental effectiveness in emission trading schemes.

The following is from the abstract of this article: “In this paper, [the authors] theoretically investigate the issues of CO₂ cost pass-through and environmental effectiveness in emission trading schemes by virtue of a Stackelberg equilibrium. [The authors] characterize the equilibrium output and price of energy product, and construct analytical derivations of CO₂ cost pass-through rates. [The authors'] findings indicate that after the introduction of emission trading scheme, CO₂ costs of energy firms are not over-shifted to energy consumers, energy supplies and demands are not excessive distortion as well. Compared to some known results, [The authors] prove that the environment effectiveness of emission trading scheme can be improved by the Stackelberg equilibrium under mild conditions. [The authors'] main results add to the theory of emission trading scheme by developing a framework where [the authors] allow for multi-stage games with observed actions, and present an optimal competition mechanism to optimize CO₂ costs and CO₂ emissions in emission trading schemes as well. More importantly, the optimal competition mechanism provides regulators and policy makers important information that can be used to design efficient and effective energy policies to trade off energy production, consumption and environmental objectives in emission trading schemes.”

Shiyong Yu, Yuke Chen, Linchang Pu, and Zhe Chen, *Energy*. (Subscription may be required.)

Integration of hydrothermal liquefaction and carbon capture and storage for the production of advanced liquid biofuels with negative CO₂ emissions.

The following is from the abstract of this article: “The technical and economic feasibility to deliver sustainable liquid biocrude through hydrothermal liquefaction (HTL) while enabling negative carbon dioxide emissions is evaluated in this paper, looking into the potential of the process in the context of negative emission technologies (NETs) for climate change mitigation. In the HTL process, a gas phase consisting mainly of carbon dioxide is obtained as a side product driving a potential for the implementation of carbon capture and storage in the process (BECCS) that has not been explored yet in the existing literature and is undertaken in this study. To this end, the process is divided in a ‘standard’ HTL base and a carbon capture add-on, having forestry residues as feedstock. The Selexol™ technology is adapted in a novel scheme to simultaneously separate the CO₂ from the HTL gas and recover the excess hydrogen for biocrude upgrading. The cost evaluation indicates that the additional cost of the carbon capture can be compensated by revenues from the excess process heat and the European carbon allowance market. The impact in the MFSP of the HTL base case ranges from -7% to 3%, with -15% in the most favorable scenario, with a GHG emissions reduction potential of 102–113% compared to the fossil baseline. These results show that the implementation of CCS in the HTL process is a promising alternative from technical, economic and environmental perspective in future scenarios in which advanced liquid biofuels and NETs are expected to play a role in the decarbonization of the energy system.”

E.M. Lozano, T.H. Pedersen, and L.A. Rosendahl, *Applied Energy*. (Subscription may be required.)

PUBLICATIONS (cont.)

**Operating flexibility of natural gas combined cycle power plant integrated with post-combustion capture.**

The following is from the abstract of this article: “Highly flexible, low-carbon electricity generation with gas-fired power stations with CO₂ capture addresses the challenges of balancing variable renewable electricity supply in low carbon electricity systems. This detailed technical assessment of flexible CO₂ capture plant operation at natural gas combined cycle power stations with post-combustion CO₂ capture examines the operating strategies of capture plant by-pass and interim solvent storage. [The authors] show that solvent storage allows expanding the operating envelope of gas fired CCS power stations by +/-10%. Further [the authors] demonstrate that electricity and CO₂ output can be decoupled for up to 3h with approx. 6000 m³ of additional solvent inventory for the purpose of reducing the CO₂ flow variability in downstream transportation and storage systems, mitigating potentially deleterious injection well effects. 1 h of solvent storage operation at full load can be regenerated in as fast as 2.1h during continuous operation of the CCS power plant by choosing a controlled steam extraction strategy from the combined cycle and thus throttling the low pressure turbine. The electricity output penalty associated with the delayed regeneration of solvent ranges from 420–450 kWh/tCO₂ with this strategy, which compares to 380kWh/tCO₂ for immediate regeneration at full load design conditions. By deploying a novel variable speed drive integrally geared compressor model, [the authors] find that, unlike previously thought, an uncontrolled steam extraction strategy, referred as a floating steam extraction strategy, can lead to choking of the CO₂ compressor during additional solvent regeneration. A pre-compression stage would be necessary under this extraction strategy to restore feasible operation of the main CO₂ compressor, and makes this strategy more complex to implement. When decreasing the desorber pressure at part-load care must, therefore, be taken to respect the operating limits of the compressor. To assist with the use of rigorous plant performance data in wider electricity system models, correlations for key performance parameters of NGCC-CCS power plants at varying load, with capture by-pass and additional solvent regeneration are provided.”

Thomas Spitz, Abigail González Díaz, Hannah Chalmers, and Mathieu Lucquiaud, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Impact of formation slope and fault on CO₂ storage efficiency and containment at the Shenhua CO₂ geological storage site in the Ordos Basin, China.

The following is from the abstract of this article: “Carbon dioxide (CO₂) storage security is a key issue in CO₂ geological storage (CGS). A three-dimensional (3D) conceptual reservoir model of the Shenhua CO₂ geological storage site in the Ordos Basin has been used to investigate the impact of reservoir formation dip and the influence of enhanced permeability fault zones on CO₂ storage and migration security. A total of 8 simulations were carried out using the TOUGH₂ integral finite difference modelling code with the ECO2N fluid property module. The simulation results showed that the dip of the reservoir formation and fault had a significant impact on CO₂ migration and storage security. Increasing the dip of the reservoir increased CO₂ migration distance, decreased the total volume of CO₂ safely stored in the formation and resulted in increased maximum gas saturation and liquid mass fraction of dissolved CO₂. The presence of fault provided a channel for CO₂ leakage and caused an irregular distribution of formation pressure. The onset time of leakage through the fault proved to be a function of formation dip, occurring at 465, 230, and 160 years following commencement of CO₂ injection for dips of 5°, 10°, and 15° respectively. The lateral extent of both the high saturation CO₂ plume and the plume of dissolved CO₂ was greater in the steeply dipping faulted reservoir model, suggesting that gently dipping un-faulted reservoir formations should be selected for future CGS projects in the Ordos Basin.”

Jing Jing, Zhonghua Tang, Yanlin Yang, and Liangzhe Ma, *International Journal of Greenhouse Gas Control*. (Subscription may be required.)

Estimating in-use wood-based materials carbon stocks in Indonesia: Towards a contribution to the national climate mitigation effort.

The following is from the abstract of this article: “The carbon sequestered in harvested wood products (HWP) can contribute to climate change mitigation. As a fast-growing country with abundant forest resources, Indonesia potentially has vast HWP carbon stocks that need to be accurately assessed as a first step towards understanding the extent of their potential contribution in climate change mitigation. In this study, a dynamic materials stock and flow analysis for carbon in wood-based products in Indonesia was conducted, covering six end-use sectors. In general, only around 30.3% of the harvested wood (carbon mass) was converted into end-use materials in 2014, indicating a significantly low harvested wood conversion rate in Indonesia. There was a significant increase of wood-based products’ carbon stocks in Indonesia from 1961 to 2016. There were 72 (-17/+15) Mt-C of wood stocks in Indonesian society in 2016, or equivalent to 0.28 t-C/capita. Buildings (42%) and infrastructure (31%) were the largest contributors to in-use carbon stocks. The product lifetime uncertainty had a significant influence on the estimate of total society’s wood-based carbon stock. Indonesia’s in-use stock of wood-based products in 2008 was below its stock level of steel (1.2 times smaller) and cement (5.3 times smaller). Both wood-steel and wood-cement stock ratios showed declining trends, indicating a shifting trend to non-renewable materials use over the past decades. This is the first study that accounts for the in-use wood-based carbon stocks in a developing country. Its results can facilitate further quantitative environmental assessments of non-renewable materials substitution and could help framing materials use policies for climate change mitigation.”

Rio Aryapratama and Stefan Pauliuk, *Resources, Conservation and Recycling*. (Subscription may be required.)

The effects of environmental innovations on CO₂ emissions: Empirical evidence from Europe.

The following is from the abstract of this article: “Environmental innovations are key enablers of transition towards greener economies. Despite their importance, empirical studies examining the effect of green technologies on CO₂ emissions are still limited. Using an autoregressive distributed-lag model (ARDL), [the authors] analyze the impact of environmental innovations, the consumption of renewable energies, GDP per capita, and degree of economic openness on CO₂ emissions for 15 European countries over 23 years. [The authors’] results indicate that, in the long-term, environmental innovations tend to lower CO₂ emissions, whereas in the short-term the observed effect is the opposite, suggesting the existence of a rebound effect. This study recommends introducing new policies that combine tools of environmental economics with those of ecological economy to integrate economic incentives with regulatory changes and encourage individuals to consume differently by favouring products and/or services with a less negative impact on the environment.”

Michelle Mongo, Fateh Belaïd, and Boumediene Ramdani, *Environmental Science & Policy*. (Subscription may be required.)

ABOUT DOE'S CARBON STORAGE PROGRAM

The **Carbon Storage Program** at the National Energy Technology Laboratory (NETL) is focused on developing and advancing technologies to enable safe, cost-effective, permanent geologic storage of CO₂, both onshore and offshore, in different depositional environments. The technologies being developed will benefit both industrial and power sector facilities that will need to mitigate future CO₂ emissions. The program also serves to increase the understanding of the effectiveness of advanced technologies in different geologic reservoirs appropriate for CO₂ storage—including saline formations, oil reservoirs, natural gas reservoirs, unmineable coal, basalt formations, and organic-rich shale basins—and to improve the understanding of how CO₂ behaves in the subsurface. These objectives are key to increasing confidence in safe, effective, and permanent geologic CO₂ storage.

The [Carbon Storage Program Overview](#) webpage provides detailed information of the program's structure, as well as links to the webpages that summarize the program's key elements.

Carbon Storage Program Resources

Newsletters, program fact sheets, best practices manuals, roadmaps, educational resources, presentations, and more information related to the Carbon Storage Program is available on [DOE's Energy Data eXchange \(EDX\) website](#).

Get Social with Us

There are several ways to join the conversation and connect with NETL's Carbon Storage Program:



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ABOUT NETL'S CARBON STORAGE NEWSLETTER

Compiled by the National Energy Technology Laboratory, this newsletter is a monthly summary of public and private sector carbon storage news from around the world. The article titles are links to the full text for those who would like to read more (note that all links were active at the time of publication).

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